دانشگاه علوم پزشکی
و خدمات بهداشتی درمانی بوشهر

«مدیریت پژوهشی »

عنوان طرح پژوهشی:

The electromagnetic interference of mobile phones on the function of a gamma camera

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سال ۱۳۹۱

گزارش تحقیق :

The electromagnetic interference of mobile phones on the function of a gamma camera

Running title: EMI effect on a gamma camera

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Abstract

Purpose: The aim of the present study is to evaluate whether or not the electromagnetic field generated by mobile phones interferes with the function of a single-photon emission computed tomography (SPECT) gamma camera during data acquisition.

Methods and materials: We tested the effects of seven models of mobile phones on one SPECT gamma camera. The mobile phones were tested when making a call, in ringing mode, and in standby mode. The gamma camera function was assessed during data acquisition from a planar source and a point source of technetium-99m with activities of 10 mCi and 3 mCi, respectively. A significant decrease in count number was considered to be electromagnetic interference (EMI).

Results: The percentage of induced EMI with the gamma camera per mobile phone was in the range of 0–100%. The incidence of EMI was mainly observed in the first seconds of ringing and then mitigated in the following frames.

Conclusion: Mobile phones are portable sources of electromagnetic radiation, and there is interference potential with the function of SPECT gamma cameras leading to adverse effects on the quality of the acquired images.

Keywords: Electromagnetic interference (EMI), mobile phones, gamma camera, single-photon emission computed tomography (SPECT)

۲ – بخش اصلی

Introduction

Communication in the 21st century changed drastically with the advent of mobile phones. Today, this invaluable means of communication has infiltrated many aspects of human life and become an indispensable tool. Given that mobile phones offer an easy-to-use and portable form of communication, medical practitioners, like so many other professionals, keep pace with mobile technological developments [1, 2]. However, the application of this technology in medical centers, despite its numerous benefits, is accompanied by some risks. These risks are based on the premise of the electromagnetic interference (EMI) of mobile phones with medical devices that are in close proximity, which results in the potential malfunction of this life-supporting equipment. Although serious medical errors as a result of mobile phone interference with medical devices have not been established definitively, incidents of interference and concomitant medical errors have been reported extensively in the literature [3-9]. According to studies performed on various types of medical devices, different levels of vulnerabilities relative to EMI have been observed, ranging from no effect to total malfunction. Due to the differences in function, shielding, and electronic devices used in the design of various medical devices, it is expected that the vulnerabilities associated with one type of medical device may differ from other types. One of the medical devices that may be susceptible to mobile phones' electromagnetic radiation is the single-photon emission computed tomography (SPECT) gamma camera. SPECT is a medical imaging system routinely used in nuclear medicine centers to take images of radionuclide distribution inside the human body. The vulnerability of the SPECT gamma camera to electromagnetic fields is mainly due to the photomultiplier tubes (PMTs) used in its structure [10]. The adverse effects of magnetic fields on the function of PMT tubes were reported prior to 1980 in former models of SPECT gamma cameras in which PMT tubes were easily affected by the Earth's magnetic field during SPECT [11]. In newer gamma cameras, PMT tubes are

well shielded in order to eliminate such interference. Although this shielding has lessened the adverse effects of the Earth's magnetic field, its protection against electromagnetic waves generated by mobile phones may be debatable. The incentive to investigate the validity of this notion was derived from a case reported during renal scintigraphy in our nuclear medicine center. We observed that during renal scintigraphy, when the gamma camera was in close proximity to the patient's mobile phone, which was located in her pocket, the ringing of the mobile phone induced adverse effects on the function of the gamma camera, causing bright spots in Frame 6 of the flow phase in the acquired image [4]. This observation led to the hypothesis, at least for our model of SPECT gamma camera, that the electromagnetic field produced by a mobile phone can interfere with the function of the PMT tubes of a gamma camera and that, in spite of having shielding against the Earth's magnetic field, they are still vulnerable to electromagnetic fields. Therefore, we decided to make a basic attempt to evaluate the function of a gamma camera during SPECT in terms of electromagnetic interference from mobile phones.

Method and material

Medical equipment

A rotating dual-head digital gamma camera (ADAC Pegasys; model SH Genesys Epic, Milpitas, California) was used to assess the possible EMI of mobile phones on the function of a gamma camera. The representative gamma camera was equipped with a low-energy all-purpose parallel whole collimator with a 20% window centered at 140 keV to provide energy discrimination for technetium-99m (^{99m}Tc), which was the source of radioactivity.

Radioactivity source

In order to assess radionuclide imaging using a gamma camera, two sources of ^{99m}Tc (i.e., a planar source and a point source) were provided. Planar distribution of the radionuclide consisted of 10 mCi of ^{99m}Tc strewn on sterile gauze with dimensions of approximately 10 cm x 5 cm. The sterile gauze was covered by a plastic bag then inserted under the gamma camera to be imaged as the planar distribution of radioactivity while the point source of radioactivity included 3 mCi of ^{99m}Tc in a vial.

Mobile phone

Seven different models of cellular phones from different manufacturers were used in this study. The representative cellular phones were the HTC 1, HTC 2, Sony Ericsson

Xperia, Samsung B7300, Nokia N86, Nokia N97, and Chinese mobile phone model H9600+. All of the cellular phones were operating with the global system for mobile communications (GSM) in the frequency of 900 MHz and a maximum output power of 2 W.

Data acquisition protocol

The gamma camera was used for the planar and SPECT acquisition of the point source and planar sources of ^{99m}Tc, respectively. Each source was used individually on the SPECT couch, and imaging was performed at fixed distance of 20 cm from the radioactive source to the surface of the gamma camera. A reduction in the count number of radioactivity in the acquired data was considered to be induced EMI in the function of the gamma camera. Two mobile phones were used for the test during planar acquisition, and six mobile phones were used during SPECT acquisition. (The Nokia N86 was used for both planar and SPECT acquisition.) The effect of each mobile phone was tested individually on the function of the gamma camera as follows:

Each mobile phone was placed on the couch next to the radioactive source. The connection was installed in a certain frame and then continued for a few of the next frames. In order to observe the electromagnetic interference of the cellular phone under test conditions exclusively and prevent the effects of any other potentially interfering sources, no portable electromagnetic equipment (e.g., cordless phones and two-way radios) was allowed in the SPECT room during the performance of the tests. The evaluation of the mobile phones' EMI was tested in three states, namely, standby mode, ringing mode, and when making a call, that is, before the connection is made. When making a call, before the receiving mobile phone rings, some electromagnetic frequencies are developed to find the location of the desired mobile phone. In this mode, which starts shortly after dialing to the receiving mobile phone and ends when it starts ringing, the receiving mobile phone generates high intensity electromagnetic radiation. The noise heard in a speaker, seconds before a receiving mobile phone rings, is a common experience in daily life.